THE IMPACT OF WEATHER VARIABILITY ON INDIVIDUAL DESIRE TO USE PUBLIC TRANSPORT IN YOGYAKARTA

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Abstract

Research on the relationship between weather and transportation has several benefits, such as to anticipate the weather-induced impacts on travel behavior and transport activities and to assist the Government to pay attention to weather factors in every decision, both in the planning and implementation of a program. Indonesia is a tropical country that has only two types of weather conditions, namely dry and rainy, and both can affect the transport system, either directly or indirectly. In this study, the perception and experience of passengers as the primary data were used to find the relationship between weather and public transportation. Then the data were analyzed through qualitative and quantitative approach. From this study it is known that the number of public transport passengers increased during heavy rains by 8.9%, when strong winds of 10.1%, and increased by 3% during hot weather. The weather also affects the desire, travel behavior, perceptions of the condition of public transport, the type of vehicle used, the time of departure, and the travel decisions.

Keywords: public transport, weather variability, travel behavior, passenger perception

Abstrak

Penelitian tentang hubungan antara cuaca dan transportasi memiliki beberapa keuntungan, seperti untuk mengantisipasi dampak yang disebabkan cuaca terhadap perilaku perjalanan dan aktivitas transportasi serta untuk membantu Pemerintah agar memperhatikan faktor cuaca di setiap keputusan, baik dalam perencanaan maupun implementasi suatu program. Indonesia merupakan negara beriklim tropis yang hanya memiliki dua jenis kondisi cuaca, yaitu kemarau dan penghujan, dan keduanya dapat mempengaruhi sistem transportasi, baik langsung maupun tidak langsung. Pada studi ini digunakan persepsi dan pengalaman penumpang sebagai data primer untuk mencari hubungan antara cuaca dan angkutan umum. Kemudian dilakukan analisis melalui pendekatan kualitatif dan kuantitatif. Dari studi ini diketahui bahwa jumlah penumpang angkutan umum mengalami peningkatan saat hujan deras sebesar 8,9%, saat angin kencang sebesar 10,1%, dan meningkat 3% saat cuaca panas. Cuaca juga mempengaruhi keinginan, *travel behavior*, persepsi terhadap kondisi angkutan umum, jenis kendaraan yang digunakan, waktu keberangkatan, dan keputusan-keputusan melakukan perjalanan.

Kata-kata kunci: angkutan umum, cuaca, perilaku perjalanan, persepsi penumpang

INTRODUCTION

Many people have some routine travel activities in daily life, such as going to work or going to school, but sometimes in a moment we need to change our daily travel pattern

because of some event could suddenly happened and changed. For example, if people tried to avoid the traffic jams, sometimes the vehicle that they want to use were not available, or even the weather changed became an unexpected moment before they were went to trip. It is known that most societal activities depend on condition of seasons and highly influenced by weather condition, especially bad weather.

The transportation sector is claimed to be one of the leading causes of environment problem, which simulate more unpredictable weather. In fact, the moment of weather can change over time (Sabir, 2011), but in recent decades, the weather condition can be predicted. Correlate to transport sector, weather may affect congestion and travel delay due to a reduction in travel time. Also, weather may influence their behavior because response that unusual condition.

The degree of influence of weather on transport sector are about people travel behavior and system of transport. The travel behavior is particularly by place and given differences in transport infrastructure. It is important to understand and forecast the plausible individual behavioral. Dijst et al. (2013) showed a rapid expansion of studies investigating the role of weather in travel behaviour during the last recent years. From a behavioral analysis point of view, we can understand to what extent the change in weather conditions determines the likelihood of a change in travel behavior. This knowledge is a crucial for analysts and policy makers to incorporate the uniqueness of local weather and climate within our policy design and infrastructure management.

The research questions of this thesis are:

1) how the weather variability affect traveler willingness to use public transport;
2) how weather variability effectively influence both everyday commuters and other commuters to use public transport; and
3) how Yogyakarta public transport condition and traveler need in various weather conditions affects their decision to using public transport.

This study has several fundamental objectives:

1) to examine the decision travel correlation in different weather condition; there is to compare the effect different intensities of rain, wind speed and temperature levels on everyday trips;
2) tto analyze how weather variability influencing travel behavior and users decision to use public transport based on their experience; and
3) to assess how the public transport condition, information system and other factor affect the users of public transport make a decision before they are going to trip.

Further expectancy through analysis in this thesis is aiming to help government and provider make some improvement and find another policy to support the passenger using public transport as comfortable especially during adverse weather condition.

The first phase of the study is qualitative explanatory of individual perception. In qualitative research, the researcher could answer the questions about social experience as deeper and gives a sense to the conclusions of the circumstances (Denzin and Lincoln, 1998). The second phase is to develop variable of travel choice and behavior, weather description and perspective based on the qualitative findings and evaluate it quantitively.

Data Collection Technique

The interview study successfully gathered 32 respondents which consist of 11 females and 21 males. The survey questionnaire has already collected 337 valid data of 352 data collected. The questionnaire data is collected by randomly disseminating questionnaires to people that ever been use public transport. The content of questionnaire survey asked about socio-demographic and activity patterns, the direct and indirect impact of weather parameters, the purpose of the travel activity, and daily travel time. Weather data also using the respondent perspective and experience, what they remember about their expertise in the last time experienced.

Data Analysis Technique

According to Creswell and Miller (2000), the process of data analysis in qualitative research is purpose to making sense out of text and image the process analysis of data. Beside of that researcher also need to explore the relationship and correlation, between exogenous and endogenous variable into an electronic database and transfer to SPSS for the statistical analysis that involved correlation analysis, factor analysis, exploratory analysis then interpreting data. Correlation analysis is a statistical method utilized in summarizing; it indicates that the manner in which a summary of the value consisted of a set of data description the degree of linear association between two measured variables (Taylor, 1990). The association interpreted by series of values ± 1, the closer r value approaches to ±1, indicates a more linear relationship between the two variables. When the correlation coefficient is zero (0), it means that no association exists between the measured variable (Field, 2013). The usual objective of factor analysis is to find the factors between variables and summarize information between the observed variables into a shorter set of unobserved variables or could be called as a latent variable (Field, 2013). After factorial analysis has done completed, the author using the regression analyzed to obtain the model from the observed data by proper a linear relation as an equation. So the Multiple Regression Analysis is conducted to measure the relationship between dependent variable and more than 2 independent variables from factorial analysis (Sadu, 2015).

The Weather Variability and Public Transport

The desire of people to travel can affect directly or indirectly dependent on several factors including the price of transportation, fuel price, taxes and one of them is the weather (Sabir et al., 2011). The role of weather is importance, especially for people who

will travel with unprotected vehicles such as a bicycle, motorcycle or walking to going to the bus stop, station or park and ride (Liu et al., 2015). In Bandung, people do not use public transport when rain is coming (Susilo et al., 2009).

Changes in weather conditions, such as rainfall, high and low temperature and high-speed wind could increase the variability in network performance (Khattak and De Palma, 1997). Namely, the variation of temperature played only a small task in the change of daily commuter trip rates considered all modes (Saneinejad et al., 2012) because the changes in travel behavior in repercussions to weather conditions were highly dependent on trip purpose (Cools et al., 2010). Rainfall has a significant impact on the traffic flow vehicle (Hranac et al., 2006; Maze et al., 2006).

Travel Behavior

Understand the traveler behavior, changes in travel patterns must be explored (Khattak and De Palma, 1997). Flexibility can be a differentiator when people want to do the business of a journey. For example, working or school activities will be less flexible than leisure because routine activities it tends to be fixed in time (Acker et al., 2010).

Weather Variability and Measurement

The standard of thermal comfort refer to SNI T-14-1993-03 cited, which divides the zone into three parts, namely: (1) cool comfortable, 20,5-22,8 °C; (2) optimal comfortable 22,8-25,8 °C; and (3) almost comfortable 25,8 °C-27,1 °C, with a relative humidity of 50%-80%. According to Ahrens (2000), the intensity of rain is the amount that falls in a given period, and the intensity of rain is base on the accumulation during a specified interval of time. The rainfall description and precipitation rate can be found in the Table 1.

Table 1 Rainfall Intensity

Rain Description	Rainfall Rate (mm/min)
Light	0.002- 0.05
Moderate	0.051- 0.100
Heavy	> 0.10

Source: Manullang, 2014.

Table 2 Beaufort Scale (Sabir et al., 2010)

0	1	2	3	4	5	6	7	8	9	10	11	12
Calm	Light Air	Light Breeze	Gentle Breeze	Moderate Breeze	Fresh Breeze	Strong Breeze	Near Gale	Gale	Strong Gale	Storm	Violent Storm	Hurricane Force
Light Winds						High Winds		Gale-force		Storm-force		Hurricane-force
< 0.3 m/s	0.3-1.5 m/s	1.6-3.3 m/s	3.4-5.5 m/s	5.5-7.9 m/s	8.0-10.7 m/s	10.8-13.8 m/s	13.9-17.1 m/s	17.2-20.7 m/s	20.8-24.4 m/s	24.5-28.4 m/s	28.5-32.6 m/s	≥ 32.7 m/s

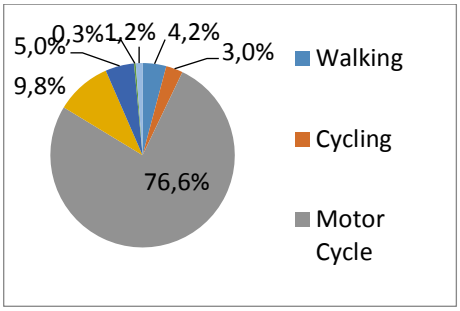
Exploratory Factor Analysis

The usual objective of factor analysis is to find the factors between variables and summarize information between the observed variables into a shorter set of unobserved variables or could be called as a latent variable (Field, 2013). If the test finds any variables that do not correlate with another variable, then it consider excluding these variables in the analysis (Taylor, 1990).

RESULT AND DISCUSSION

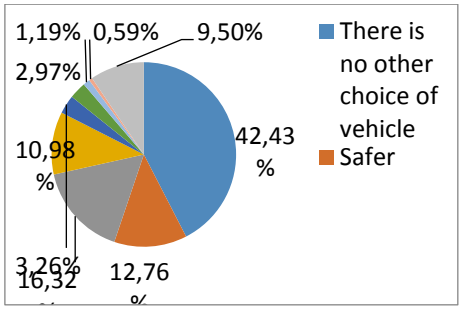
Travel Behavior in Every Day Activity

The propensity to change, i.e. the adjustment process itself depends on personal characteristics and household attributes, trip characteristics, situational factors, weather and travel information. It is expected that people will replace their most convenient or least disruptive travel decision before going to travel. Form the result of study, only a few people often and always uses public transport; it is around 3% and 10% of the total sample. That is in line with that expressed by Susilo et al. (2007) and Munawar et al, (2007). In their research which is provided information that the desire of people using public transport in Yogyakarta is very low. It can also be seen in Figure 1 of their reasons when using public transport, the majority of the respondents acknowledge that their reason using public transport are mainly because of there is no other choice of vehicle (43%) or in other words, people use public transport due to forced not because of public transport as their main modes in conducting the daily commute, this result also in line with Susilo,et al. (2007) and Munawar (2007). Another common reason expressed by the respondents that they use public transport because public transport is cheaper than other modes of transportation (14.8%) can be seen in Figure 2. These results conform to research carried out by Susilo et al. (2009). However, in their research "cheaper" became the popular reason why people in Indonesia would be willing to use public transport than other mode.



(a)

Figure 1 Frequency of Using Public Transport (a)



(b)

Figure 2 Frequency of Using Public Transport (b)

Weather Effect on Travel Behavior

The travel behavior is indeed the tendency of Yogyakarta people will choose to stay at home, especially when it rains, as much as 51.6% of respondents agree with that. When people want to travel, respondents agreed (53.1%) they tend to replace their departure time when it was raining (Khattak and De Palma, 1997; Snelder and Calvert, 2016). Table 5 explained that the reason people continue a journey depend on degree of importance of objectives travel (52.8%) and based on departure time flexibility (55.5%).

Another tendency of the respondents, they will wait for rain leave off or waiting the weather back to normal circumstances before making the trip (52.3%). The tendency of people waiting could be due to the perception of individuals on travel time, safety and traffic conditions (Bocker et al., 2012). Most respondents have the perception, that when it rains the travel time will be longer (42.7%), the accident opportunity will be greater (36.8%), and people think traffic will congested (51.3%). Addition to daily activities, respondents also agreed if the weather does not only affect his travel behavior but also can influence the quality of public transport services (54.9%).

In addition during the rainy conditions of respondents consider the level of temperature as much as 38.9% of people agree that the temperature makes them prefer to stay at home rather than traveling, but most respondents argued they were not affected by the condition of the air temperature during the activity (43.9%). The desire of people to stay at home may because they think that traffic condition would be congested, especially when it rains (51.3%). However, the results of the survey, respondents did not agree if they knew it will rain, then they would cancel the trip (41.5%).

Effectiveness of Weather Condition in Influencing Travel Mode Choice

An average people replace mode of transportation when the intensity of rainfall, temperature or wind speed is increase to high level, despite not all people do things like that. From the study, it can be seen when the intensity of the rain is still small (drizzle) people tend to use the mode of transport that they usually use, as well as when the rain intensity is considered quite high, they will looking for alternatives other vehicles that can protect them more.

The temperature is also an influence on mode choice, of studies have shown people tend to use vehicles other than motorcycles during hot weather than when the weather is cold. As for windy conditions, more respondents does not like using motorcycles (Figure 3). It may because the wind may affect the infrastructure of the urban transport or inter-city highways and rail because of falling trees or because of overturning (Sabir, 2011) and also it is are prone to get accidents. However, it is the trend of using the motor in Yogyakarta for daily travel activities is quite high.

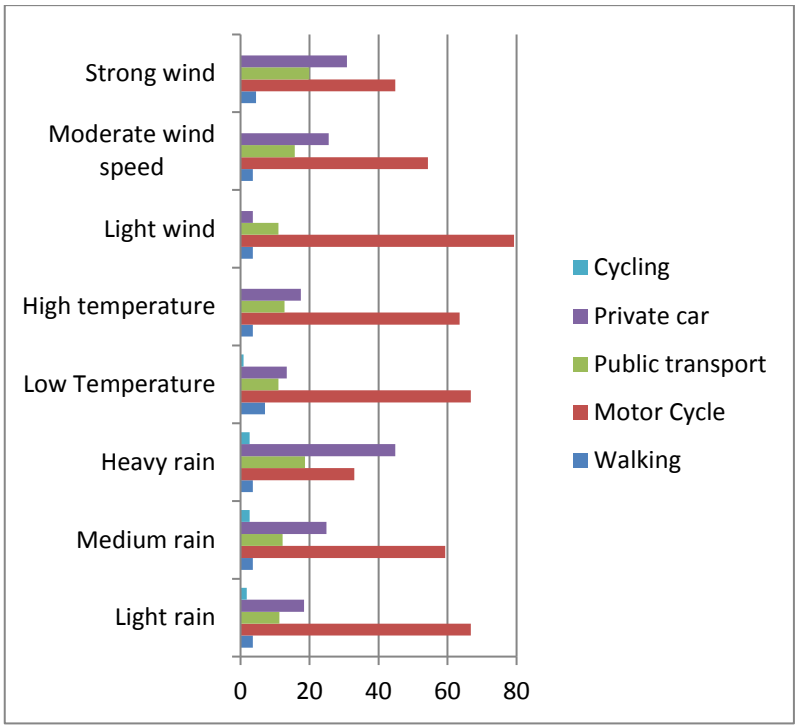


Figure 3 Mode Choice During any Weather Condition

Influential Factors on Traveler Decision to Use Public Transport

Based on pre-study, there are other factors beyond than just the weather may affect someone decision, such as the condition of public transport and habits or behavior of people in daily travel. The model presented in factor analysis method contains sets of variables and it is necessary to reduce the number by doing a selection in the Table 3 show latent variable categories from factor analysis.

The selection should secure that the "right" variables are take into the further analysis. The result of the explanatory factor analysis will be used to subsequent analysis (multiple regression analyses).

$$Y = 2.398 + 0.108\ X_1 + 0.547\ X_2 + 0.066\ X_3 + 0329\ X_4 \quad (1)$$

with:

Y = Desire to use public transport in daily travel.

X_1 = Variable "Public transport facilities and condition".

X_2 = Variable "Travel choice".

X_3 = Variable "Travel behavior".

X_4 = Variable "Weather condition".

Table 3 Factor Analysis Categories

Factors	Attributes	Factor Label
1	1. Availability Park and ride 2. Safety information and explanation 3. On schedule of public transport 4. Accuracy of the info of delay duration 5. access to public transport 6. Distance to shelter 7. Station has an excellent protection 8. Information about departure time of PT 9. Weather forecasting information	Public transport facilities and condition
2	1. Always Use PT in all wind condition 2. Always Use PT in all temp condition 3. Always uses public transport during rainy day 4. Always uses car during rainy day 5. prefer to wait because think that will congestion	Travel choice
3	1. Keep going and change departure time 2. Will waiting until weather back to normal 3. Use motorcycle in daily travel	Travel behavior
4	1. Temperature effect on your travel 2. The Wind effect to your travel	Weather condition

A regression analysis was deployed to investigate which variable or attribute on people daily travel activity influence decision of passenger to use public transport. It is summarized that the model has R-square = .546. all of factors are statistically significant toward the dependent variable, that is, Factor 1 "Public transport facilities and condition" (beta = .108, p-value = .00), Factor 2 "Travel Choice" (beta = .547, p-value = .00) Factor 3 "Travel behavior" (beta = 0.066, p-value = .00) Factor 4 "Weather condition" (beta = .329, p-value = .00) which indicated that the activation regression model was significantly reliable as predictors.

CONCLUSION AND RECOMMENDATION

According to the above results it can be concluded that:

1) Based on the survey, the weather conditions affect the choice of individuals to use public transport. The results show that even though the weather is embedded in people daily lives. The Number of people tends to use public transport increase when it rains, and temperature has an impact on people decision, but there is also a range of other factors that influence the decision such as public transport condition.
2) As this report indicates, the people of Yogyakarta willingness if transport facilities improved beforehand, so that when people of Yogyakarta will use public transport in various weather conditions do not make people disappointed because of their choice to use public transport makes them longer and more difficult. Yogyakarta community propensity to use private vehicles, especially private car, is still quite large even during heavy rain (44.8%) compared with propensity to use public transport (18.7%). It

became evident that the existence of public transport in Yogyakarta is not effective in reducing private vehicle users.

3) Besides weather factors, the behavior, habits of people travel in every day, and public transport conditions in a wide variety of weather is the dominant factor affecting the interest of someone to use public transport.
4) Overall results of the survey, the majority of respondents prefer using motorcycles for everyday activities (work or school) even though they have a car. The temperature is also an influence on mode choice, of studies have shown people tend to use vehicles aside motorcycles during hot weather than when the weather is cold. As for windy conditions, more respondents does not like using motorcycles. For rainy condition people tend to use private car.

The recommendations can be given as follows:

1) The facility of public transport should be done improvement and be able to cope various weather condition by provider or authority to gather number of passenger of public transport. The first thing and most important that need to improving and add up the park and ride facilities.
2) The need for protection on access facility from parking site to the station in order to provide comfort and good protection. For example, could add a canopy along the access to the station.
3) The reliable of weather information and information system have to improving, then people will using that information to make a decision before going to travel as precisely.
4) The shelter condition should be improved by provider or authority order to protect the passenger in all weather condition.

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